

Growth of Statistics Enhanced by Computer and Internet

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Abstract

Introduction of computer has changed the way we think, and the creation of internet has revolutionised the way we do things at home and work. Together they have made tremendous advances in statistical methods, analyses, research and teaching, along side many other aspects of modern life. This paper explores the extent and depth of impact that computer and internet have made in various statistical activities. Particular emphasis is on the ways of data production, management, analysis and publication as well as the teaching and research tools that are crucial to promoting statistical knowledge, skills and applications. Some illustrations of the inevitable changes already adopted in various statistical activities are highlighted.

1. Introduction

Beyond doubt the use of information and communications technology (ICT) has become a part of life in the modern world. Like many other spheres of life, it has impacted on the education industry as a whole, and particularly in the higher education sector. As a result it is of utmost interest to the academics, policymakers, and managers within and outside the industry (cf Andrews 2004, Shiraz et al. 2010). It is also an important consideration to the publishers, instructional designers, and developers of educational technologies. The computer and ICT are used to address the changing mode and nature of the industry for more flexible learning; extension of university services to national and international markets; and more cost-effective delivery of higher education in an increasingly competitive environment. The growing use of ICT in education is a part of a wider technological revolution, evidenced by the increasing use of computers and internet; growth of the on-line economy; keen competition in communication services; and broader public policy environment regarding the learning community and the use of educational technology. The use of computers and internet in the education industry is growing faster and spreading to other sectors of economy very quickly. As such it is essential to study its impact on the statistical activities in a broad sense.

Increasingly Statistics is being used almost everywhere in the contemporary society. Both public and private enterprises use statistics for decision making and planning. Statistics has expanded its pivotal role far beyond its origin and traditional areas in agriculture, social science and business, and now has secured its ever increasing role in the space, climate, environment, engineering, health and medical research. As an emerging discipline, Statistics has adopted very well with the ongoing technological changes, and found many previously unknown areas of applications. The robustness of Statistics to adopt with the changing and diverse situation and its power to making decisions in the face of uncertainty has made it more relevant and appealing to the modern science and way of life.

Like almost all other areas of the contemporary learning and teaching, the advent of computer has been a tremendous boost in the development and applications of statistical methods. It has remarkable impact on the collection, management and analysis of data and preparation of reports. Without computers it would have been impossible to manage and analyse the vast array of data collected by different corporations, hospitals, government offices, industry and business enterprises, and regional and international agencies.

The internet has accelerated the transfer and accessibility of data in an unthinkable pace and beyond almost all limits. The time is a very insignificant issue when it comes to using data from anywhere in the globe. The reduced cost and convenience of internet to transfer data has made business and Government more profitable, let alone efficient. It has brought the goods and services to the door steps of the customers and clients. It has also almost removed the time constraints of the users and clients as they could use the resources and services at their own time and pace, and from their home or office without having to travel to get it done.

The computer has made a revolutionary change in the way education industry works. The design, preparation, delivery, submission and management of assessments and evaluation of courses have changed for ever due to the use of computers. The significant move from printed to electronic resources in the teaching and research is solely due to the introduction and availability of computers at home and educational institutions. Introduction of multimedia and electronic data projector along with a wide range of statistical packages and softwares have made teaching of statistics much easier. Most of the learners find it much easier to grasp many complex statistical concepts through computer simulations and hands-on computations. The computer managed assessment (CMA) and many associated open source softwares have significantly affected the traditional assessment management system. The student feedback on the assessments has also been simplified and faster using the computer and internet.

Some well-known universities have joined forces to create and run what is known as the **massive open online course (MOOC)** <http://www.mooc-list.com/> an online course offering system aimed at large-scale interactive participation and open access via the web. Commercial providers like Coursera <https://www.coursera.org/> has also developed and running a large number of online courses.

In the next Section we provide some recent data on the usage of computer and internet in different parts of the world. Section 3 deals with Statistical activities and computers. Use of computers and internet in the teaching and learning of Statistics is covered in Section 4. The final Section provides some concluding remarks. The Appendix contains additional information on the materials and educational technologies relevant to the teaching of Statistics.

2. Contemporary Status of Computer and Internet

Nothing else is growing faster than the use of computers and internet in the contemporary world. The data on the ownership of computers and subscription and use of internet reveal that more and more people are embracing the technology. Day-by-day the use of ICT is becoming an essential part of our life, and it is no more a choice, rather a necessity for the survival in the ever competitive world. Here we provide some recent data on the ownership and use of

computers and internet to reflect on how the ICT is making remarkable impact on our education, society, lifestyle and economy.

2.1 Computer access data

First we provide recent data on computer access for some selected members of the Organisation for Economic Cooperation and Development (OECD), a group of developed nations, and Organisation of Islamic Cooperation/Conference (OIC) countries, an association of Muslim majority states, separately. The graphs and tables show the remarkable growth in the access to computers in the recent past. A brief comparison and analysis of the data are also provided to re-enforce the impact of the ICT on the contemporary world. The following OECD data can be accessed from the link at <http://www.oecd.org/>

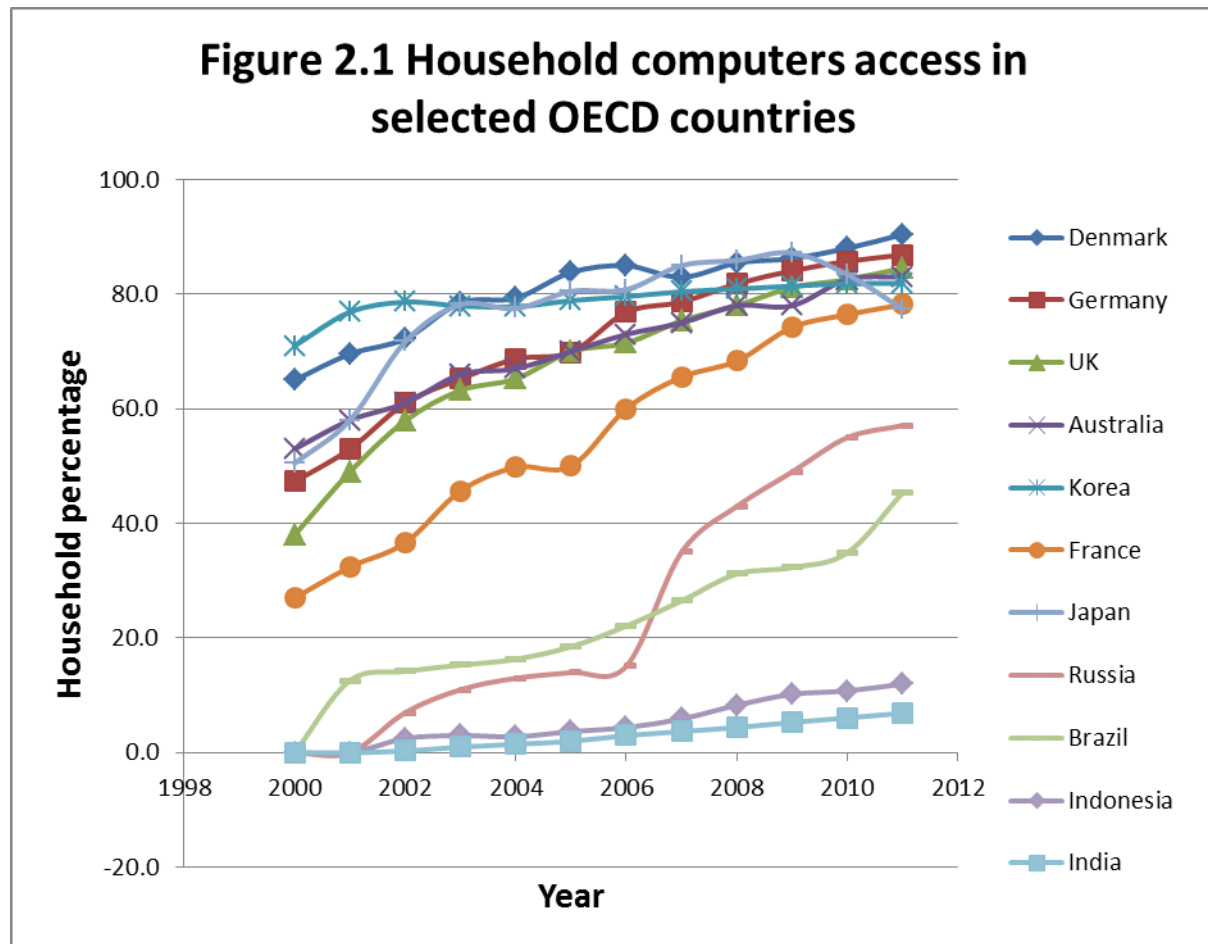
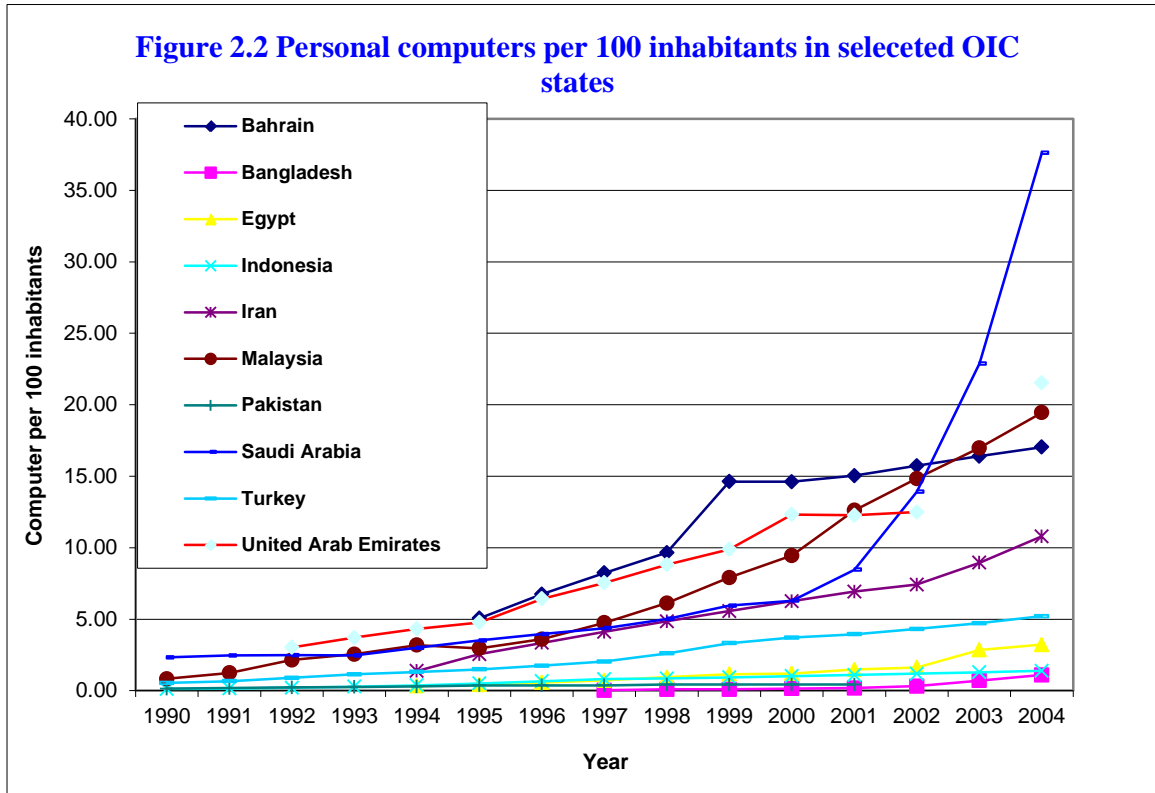


Figure 2.1 represents the time series data on the access to household computers during 2000-2011 for selected OECD countries. The lowest percentage of access to home computers is in India (6.9% in 2011) and it is clearly remarkably lower than the other countries in the graph followed by Indonesia (12.0%). In 2011, Denmark has the highest percentage of household access to computers (90.4%) in the OECD countries. Germany (86.9%), UK (84.6%), Australia (83%), Korea (81.9%), France (78.2%), and Japan (77.4%) are the other OECD countries with higher computer access at home. Russia (below 7% to 57.1%) and France (27% to 78.2%) appear to be fastest growing countries on the list during 2000-2011.

Figure 2.2 provides information for a group of representative member states of the OIC countries, and shows that the inhabitants owning personal computers was steadily increasing from 1990 to 2004. There seems to be higher rate of growth of computer ownership in 2000 or later than prior to 2000. However, the rate of growth appears to be slow in countries with lower gross domestic product (GDP) than those of the higher GDP. Although in 1995 the difference in the percentage of ownership of computers varied from 0.41% in Egypt to 4.78% in United Arab Emirates, the same stands to be from 1.10% (Bangladesh) to 37.62% (Saudi Arabia) in 2004. There is a very sharp rise in the figure in Saudi Arabia after 2001, followed by Malaysia after 2000. The rate of growth in Bahrain is significantly lower after 1999. Although the growth rate widely varied among the countries, no country had negative growth during the period. In 2004, the highest number of computer owners per 100 inhabitants was in Saudi Arabia (about 37.62%), followed by Malaysia (19.45%), and the lowest in Bangladesh (1.10%) followed by Indonesia (1.39%). The latter two countries are among the largest three members of the OIC states. Turkey, Malaysia and Iran maintained relatively stable but increasing growth rate of the computer ownership. Visit http://www.sesrtcic.org/stat_database.php for the data on OIC countries.



2.2 Internet subscription and usage data

Data on the subscription and usages of internet for selected OECD, Middle East (ME) and OIC countries are provided here separately. The graphs and tables show the phenomenal growth in the subscription and usage of internet in the recent years. See Internet World Statistics, for details on the data of OECD and ME countries, at <http://www.internetworldstats.com/stats5.htm>

Table 2.1 Selected OECD Countries Internet Usage and Population Statistics

OECD Countries	Population (2007 Est.)	% Pop. OECD	Internet Usage, Latest Data	% Population (Penetration)	% Users OECD	Use Growth (2000-2007)
<u>Australia</u>	20,434,176	1.7 %	15,504,532	75.9%	1.2%	134.9 %
<u>Denmark</u>	5,468,120	0.5 %	3,762,500	68.8%	0.3%	92.9 %
<u>France</u>	63,718,187	5.4 %	34,851,835	54.7%	2.6%	310.0 %
<u>Germany</u>	82,400,996	7.0 %	53,240,128	64.6 %	4.0 %	121.8 %
<u>Italy</u>	58,147,733	4.9 %	33,143,152	57.0 %	2.5 %	151.1 %
<u>Japan</u>	127,433,494	10.8 %	87,540,000	68.7 %	6.6 %	85.9 %
<u>Korea</u>	49,044,790	4.2 %	34,910,000	71.2%	0.4%	121.4 %
<u>Turkey</u>	71,158,647	6.0 %	16,000,000	22.5 %	1.2 %	700.0 %
<u>United Kingdom</u>	60,776,238	5.2 %	40,362,842	66.4 %	3.1 %	162.1 %
<u>United States</u>	301,967,681	34.7 %	210,575,287	69.7 %	42.2 %	120.8 %
OECD, total	1,178,383,039	100.0 %	690,430,444	58.6 %	100.0 %	144.2 %

NOTES: (1) The Organisation for Economic Co-Operation and Development (OECD) Internet Statistics were published for December 31, 2007. (2) The demographic (population) numbers are based on data contained in the [Census Bureau](#). (3) The Internet usage information comes from data published by [Nielsen/NetRatings](#), [ITU](#), and other local trustworthy sources.

Table 2.1 presents data on the usage of internet in some selected OECD countries along with the population and growth of internet usage during 2000-2007. The smallest increase of usage (85.9%) is recorded in Japan. However, Japan may already had a higher level of usage of internet before 2000 and hence the increase after 2000 is not a surprise. This may be supported by the fact that Denmark has a growth of 92.9%, much lower than some of the other countries where internet has become popular in the recent past. In the table, Turkey has the highest growth rate of (700.0%) usage of internet. This is a phenomenal increase by any standard. Nevertheless, this may be due to the fact that the level of usage of internet in Turkey was much lower prior to 2000 and it picked up very rapidly during 2000-2007.

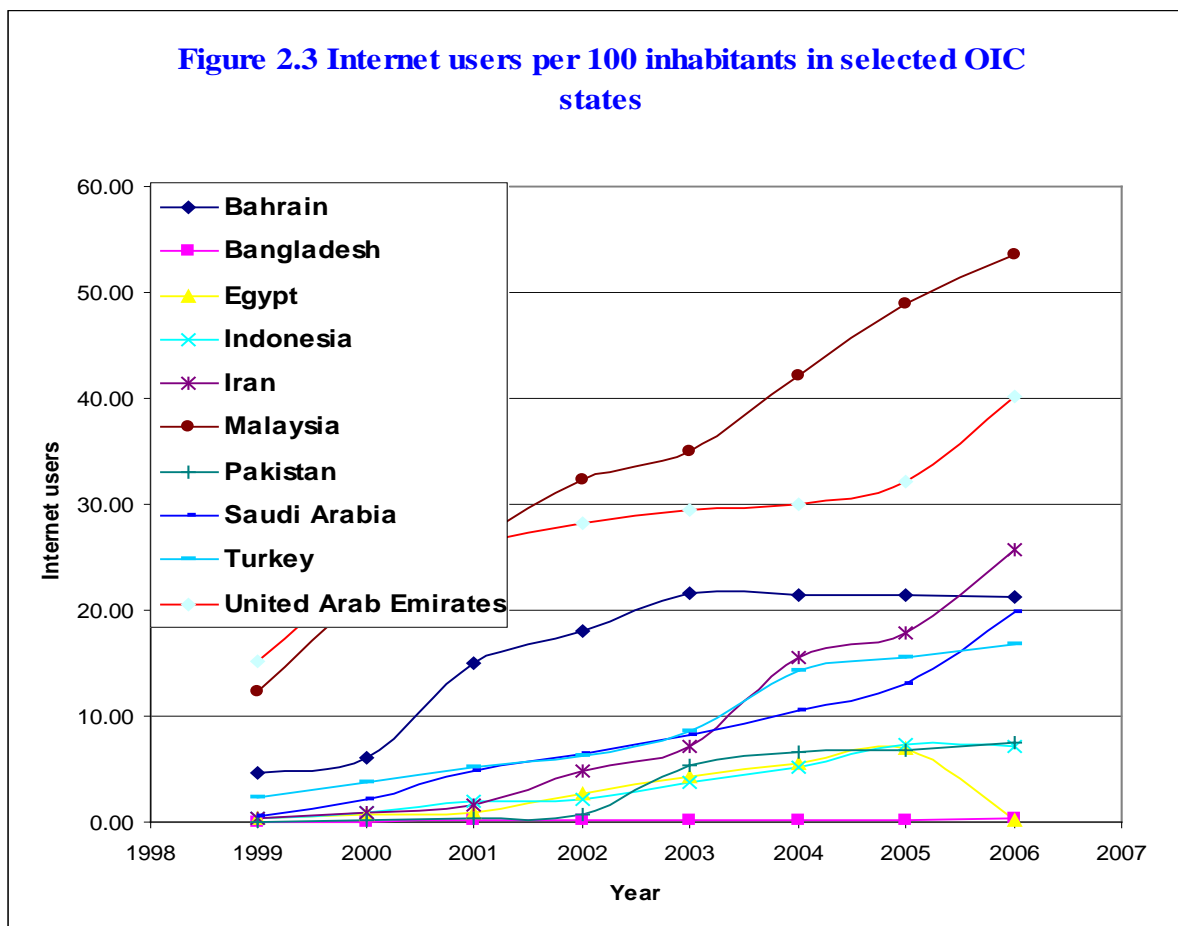
Table 2.2 Middle East Internet Usage and Population Statistics

MIDDLE EAST	Population (2007 Est.)	Usage, in Dec/2000	Internet Usage, Latest Data	% Population (Penetration)	(%) of M.E.	Use Growth (2000-2007)
<u>Bahrain</u>	708,573	40,000	157,300	22.2 %	0.5 %	293.3 %
<u>Iran</u>	65,397,521	250,000	18,000,000	27.5 %	53.7 %	7,100.0 %
<u>Iraq</u>	27,499,638	12,500	36,000	0.1 %	0.1 %	188.0 %
<u>Israel</u>	6,426,679	1,270,000	3,700,000	57.6 %	11.0 %	191.3 %
<u>Jordan</u>	6,053,193	127,300	796,900	13.2 %	2.4 %	526.0 %
<u>Kuwait</u>	2,505,559	150,000	816,700	32.6 %	2.4 %	444.5 %
<u>Lebanon</u>	3,925,502	300,000	950,000	24.2 %	2.8 %	216.7 %
<u>Oman</u>	3,204,897	90,000	319,200	10.0 %	1.0 %	254.7 %
<u>Palestine(West Bk.)</u>	2,535,927	35,000	266,000	10.5 %	0.8 %	660.0 %
<u>Qatar</u>	907,229	30,000	289,900	32.0 %	0.9 %	866.3 %
<u>Saudi Arabia</u>	27,601,038	200,000	4,700,000	17.0 %	14.0 %	2,250.0 %

Syria	19,314,747	30,000	1,500,000	7.8 %	4.5 %	4,900.0 %
United Arab Emirates	4,444,011	735,000	1,708,500	38.4 %	5.1 %	132.4 %
Yemen	22,230,531	15,000	270,000	1.2 %	0.8 %	1,700.0 %
TOTAL Middle East	192,755,045	3,284,800	33,510,500	17.4 %	100.0 %	920.2 %

NOTES: (1) The Middle East Statistics were updated as of December 31, 2007. (2) The demographic (population) numbers are based on data from the [Census Bureau](#). (3) Internet usage numbers come from various sources and are compiled here, see the [site surfing guide](#). (4) Data may be cited, giving due credit and establishing an active link back to [InternetWorld Stats](#).

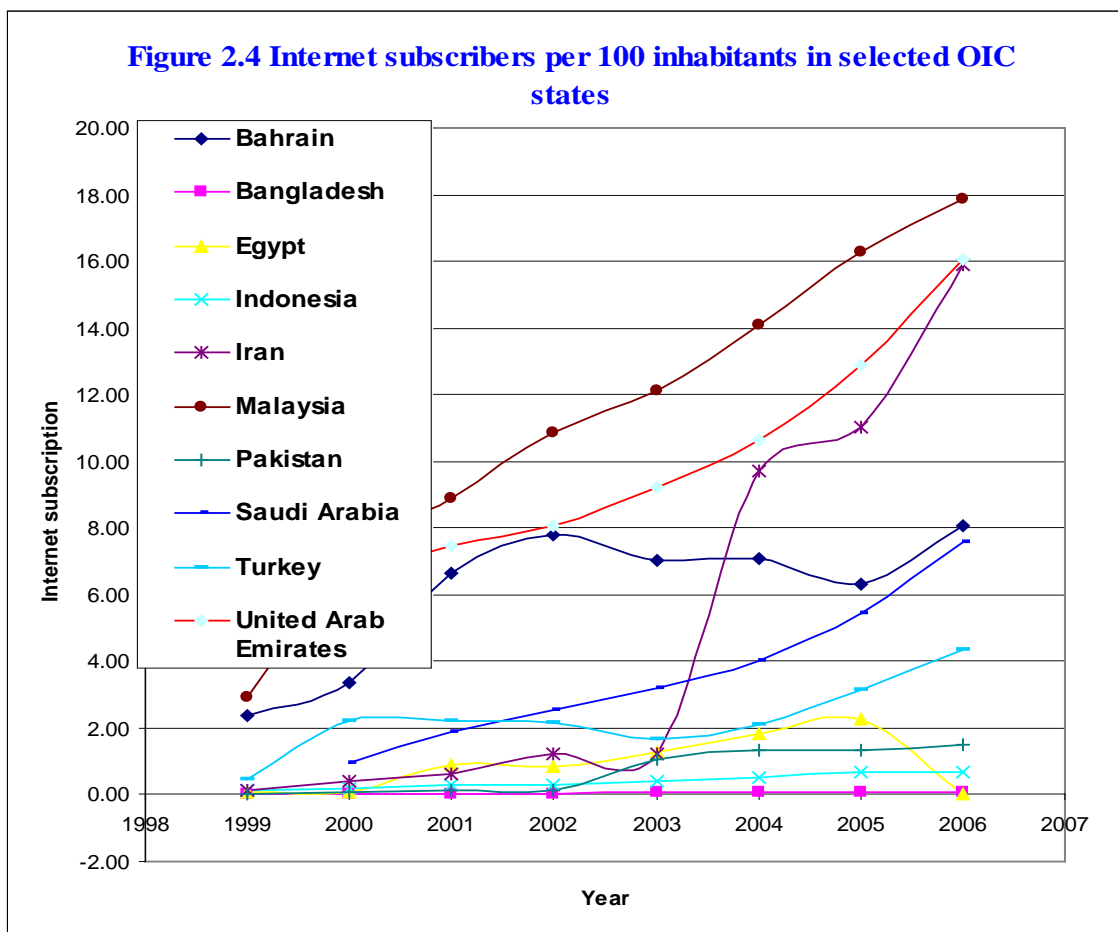
Data on the population and usage of internet in the Middle Eastern (ME) countries are provided in Table 2.2. The table clearly shows that growth of internet usage differ significantly from one country to another. It is unbelievable that there has been 7,100% growth of internet usage in Iran. Only reasonable explanation to this figure would be there was very little internet usage in Iran before 2000 for some reasons. Similarly, Syria had 4,900% and Saudi Arabia had 2,250% growth in internet usage. The lowest growth (132.4%) is reported in United Arab Emirates (UAE). This may be explained by the higher level of usage of internet in the UAE prior to 2000. In terms of penetration among the population, Israel (57.6%) has the highest score followed by the UAE (38.4%). The lowest penetration is recorded in Iraq (0.1%) followed by Yemen (1.2%) and Syria (7.8%).



From Figure 2.3, the internet users of the selected member states of the OIC countries have steadily increased from 1999 to 2006 except for constant growth in Bahrain from 2003 to 2006. The rate of growth of internet use has rapidly grown in 2000 or later than prior to 2000. However, the rate of growth appears to be slower in countries with lower GDP (eg Bangladesh and Indonesia) than those with higher GDP (eg Malaysia and UAE).

In 1999, the rate of internet use varied from 0.07% in Bangladesh to 23.56% in United Arab Emirates, the same stands to be from 0.29% (Bangladesh) to 53.27% (Malaysia) in 2006. There was a very sharp rise of internet use in Iran from 2003 (7.16%) to 2006 (25.68%). For reasons unknown, the rate of growth in Bahrain actually remained almost unchanged during 2003-2006.

In 2006, the highest number of internet user per 100 inhabitants was in Malaysia (53.57%), followed by United Arab Emirates (40.21%), and Iran (25.68%). The lowest rate was in Bangladesh (0.29%) followed by Indonesia (7.17%) and Pakistan (7.55%). The latter three countries are the largest three members of the OIC states. Saudi Arabia, Turkey, Malaysia and UAE maintained relatively stable but increasing growth rate of the internet usage.



From Figure 2.4, the internet subscription of a selected group of representative member states of the OIC countries shows steady increase from 1999 to 2006 except for some irregular (very fluctuating) figures for Iran and Bahrain. The rate of growth of internet subscription has more

rapidly grown in 2000 and later than prior to 2000. Although, the rate of growth appears to be slower in countries with lower GDP than those with the higher GDP.

In 2000, the percentage of internet subscribers varied from 0.04% in Bangladesh to 6.45% in United Arab Emirates, the same differs to be from 0.10% (Bangladesh) to 17.86% (Malaysia) in 2006. There is a very sharp rise of internet subscription in Iran from 2003 (1.22%) to 2006 (15.88%). For reasons unknown, the rate of growth in Bahrain actually went down during 2003-2005, but has picked up in 2006.

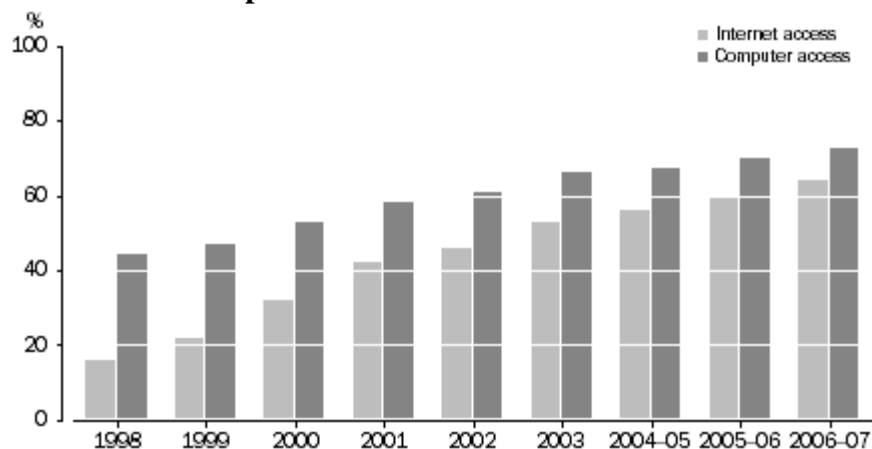
In 2006, the highest number of internet subscribers per 100 inhabitants was in Malaysia (17.86%), followed by United Arab Emirates (16.09%), and Iran (15.88%). The lowest rate was in Bangladesh (0.10%) followed by Indonesia (0.67%) and Pakistan (1.51%). The latter three countries are the largest three members of the OIC states. Saudi Arabia, Turkey, Malaysia and UAE maintained relatively stable but increasing growth rate of the internet subscriptions.

In the OIC countries, the subscription and usage of internet in the countries with lower GDP (eg Bangladesh and Indonesia) is lower than those with higher GDP (eg Malaysia and UAE).

2.3 Use of Computer and Internet in Australia

In 2006-07, 64% of Australian households had home Internet access and 73% had access to a home computer. During 2006-07, whilst the proportion of households with access to the Internet increased by 4 percentage points, in the same period, the proportion of households with access to a computer increased by 3 percentage points.

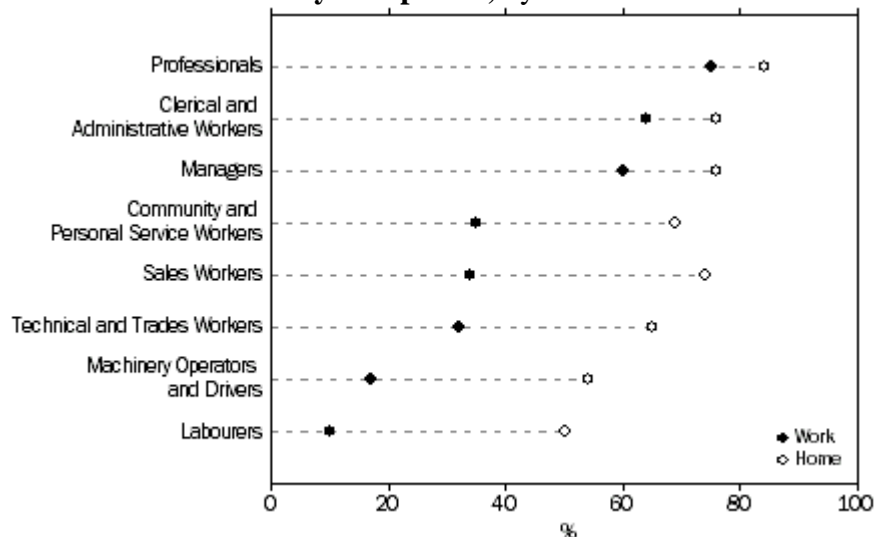
Figure 2.5 Household computer and internet access in Australia - 1998 to 2006-07



LABOUR FORCE CHARACTERISTICS OF INTERNET USERS

In Australia, during 2006-07, Professionals (75%), Administrative or Clerical Workers (64%) and Managers (60%) were most likely to use the Internet at work. Labourers were least likely to use the Internet at work (10%). Similar trends were found for Internet use at any location which incorporates home use as well as other locations such as libraries, educational institutions and other persons' homes.

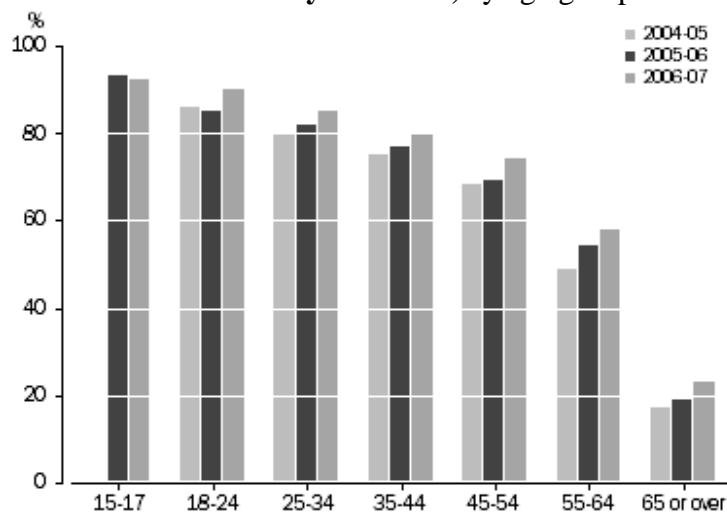
Figure 2.6 Use of the Internet by occupation, by location of Internet access, 2006-07



SOCIO DEMOGRAPHIC CHARACTERISTICS OF INTERNET USERS

The use of the Internet at any location was significantly higher than the average for those with the following characteristics: those in the age group 15 to 17; people from households in the top two income quintiles; people with higher levels of educational attainment and the employed. In contrast, older people, people with below median household income and the unemployed registered significantly lower than average levels of Internet access.

Figure 2.7 Use of the Internet at any Location, by age group - 2004-05 to 2006-07



Overall, 61% of people aged 15 years and over accessed the Internet at home during 2006-07. Personal or private purposes was stated as the most popular purpose of Internet use at home (98% of those using the Internet at home), followed by education or study purposes (53%). 68% reported Personal or private purposes as the main purpose of Internet use, followed by Work or business related purposes (17%) and Education or study related purposes (12%).

Figure 2.8 Main purpose of internet use at home, 2005-06 to 2006-07

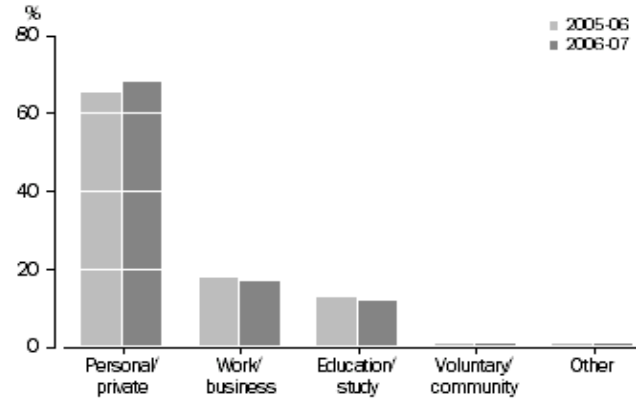
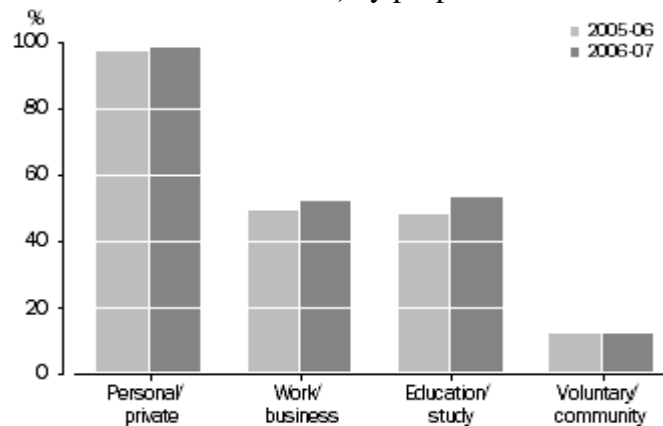


Figure 2.9 Internet use at home, by purpose-2005-06 and 2006-07



Clearly the education or study is a dominant purpose of use of internet at home. It would be more so at the educational institutions and providers of educational material and technologies.

3. Computer in Statistical Activities

Any applied statistical studies involve varieties of activities that require computer. In most of the cases, the main activities include design of survey or experiment, production, collection, management of data, presentation/summarising data, and making conclusion/inference based on sample data. In addition statistical teaching, research and publications of raw data or reports based on the analysis of data are essential parts of statistical activities. All of them require the use of computers these days, and often internet is used to faster communication of results and quick dissemination of publications both locally and globally. The use of electronic questionnaire is becoming increasingly popular in many places, particularly in the business, transport and health sectors.

3.1 Data Collection and Management

The basic raw material of statistics is data. Computers are essential for the compilation and formatting of raw data and any further analyses. It is customary to produce simulation data using computers. Monte Carlo simulation is a common way of producing data using any suitable computer package or program. Computers allow drawing of random samples, or generate random variables, from any distribution of interest in a very scientific and efficient way. It is handy, convenient, economical and time efficient.

Data management has never been easier than now. This is absolutely due to the advancement of computers and data management system. Not only we are able to store and manage huge range of data in computers, but also we could preserve them in a way we want, and make them available in any format of our choice and need. This has made the data management very user friendly and flexible for the users. Better data management has made data analysis easier with increased accuracy, comparability and timely delivery.

3.2 Data Analysis

In the contemporary world, statistical data analysis without computer and statistical packages is unthinkable. Computers have become the only vehicle for statisticians to produce useful results from raw data. Starting from simple descriptive statistics and graphs to reveal the hidden useful information in the raw data to sophisticated computations for more complicated procedures computer is the only way to go. The preparation of reports and publication of final results are all done using computers. Electronic publications are growing too fast as a cheaper alternative to conventional paper based publication. Such an alternative saves time and cost as well as reduces the undesirable wastes that are threatening the global environment.

There are many statistical analyses where use of computer is essential. Analyses of long time series data, panel data and forecasting as well as data mining processes are very computer intensive. Many Bayesian methods including Gibbs sampling and Markov chain Monte Carlo (MCMC) procedure are fully dependent on computers. Several statistical packages, including WinBUGS and OpenBUGS, dedicated to such methods are freely available for researchers and users.

3.3 Teaching and learning

Computers and internet have made tremendous impact on teaching and learning at all levels of education. Many textbooks and other learning resources are being published electronically. Increasingly the teachers are using computers to produce course materials and delivering it. Both face-to-face and distance delivery are dependent on computers. The electronic data projector has made it lot easier for the instructors to deliver their lectures with opportunity to explain the difficult concepts with graphs and charts along with appropriate examples with visual representation. Demonstration of the Central Limit Theorem, explanation of the concept of Sampling Distribution, illustration of the principle, logic and reason for Statistical Tests, and interpretation of Confidence Intervals have become so convincing due to the computer simulation. Posting lecture and tutorial notes on the web prior to the class helps students to bring it in the lectures so that they could spend more time on the understanding of statistical thinking and concepts, rather than copying the old fashion lecture notes from the whiteboard.

Recoding of lecture, tutorial and laboratory sessions and making them available to the students via internet, especially to external students are becoming a regular practice for the institutions offering online courses. Khan et al. (2010) discussed the benefits of screencasting that captures the computer screen text/graph/photo along with the audio using Camtasia Recorder for the posting on the studydesk, a platform for teaching resources for students. The Tablet technology allows to write on the computer screen making Statistics teaching much easier. Webiner enables distant presenter to talk and share screen at the same time with anyone linked from anywhere in the world.

3.4 Research and training

Research and research training in Statistics have changed dramatically with the availability of computer and internet. The main source of research materials are journals and other publications containing latest development in the field. Many publishers are now publishing electronic journals and books that are accessible by computers via internet. The management of submission and review of articles in many journals are electronic and online. This has eliminated the need for hardcopy for the reviewers and the editors. Proofreading of accepted articles and processing of copyright are also done electronically.

Many statistical researches are by nature computer intensive, and require more computational skills and training than just using some statistical packages and writing of computer programs. Computer is the only means to conduct research where simulation is inevitable due to non-availability of any real data.

3.5 Report preparation and publication

Internet is used for varieties of statistical activities. Electronic forms or questionnaires are used to collect data on the internet. Such data are often automatically compiled, saved and stored electronically. Updating of results is also automatically done as the new data become available. It is a great means of data dissemination and sharing of resources to be used by partners and stakeholders from different locations across the globe. It makes the reports and documents easily accessible around the clock for all the users globally.

Communication of results and analyses to the users and stakeholders are some of the main objectives of statistical studies and research. Like the storage and management of data, computers are used for the preparation of reports based on the results produced by statistical analyses. Statistical analyses of data are performed using appropriate statistical packages and programs. The prepublication drafts and editing of reports are all done online via computers. Internet is used to share data and analyses for people working in different locations at different time as part of any study/research team. Inputs and suggestions for changes, corrections, modifications or addition from members of the team are also collated via internet.

4. Computer and Internet in Teaching Statistics

Even in the early second half of the last century, Statisticians used non-electronic hand calculators to compute and teach statistics in the laboratory. The same old style machine was also used to calculate statistical results by users at large. As a result, extensive use of various approximations and transformations were essential to calculate different statistics and verify useful results. Use of Statistical and Mathematical tables were only means to perform statistical tests, and find critical values for confidence intervals. Although various Statistical tables are still in limited use, any computer package is able to do a much better job now-a-days without even taking any notice of the tables. These packages directly produce the P-value (observed significance level) for various tests, and critical value for confidence interval of desired confidence level without using Statistical tables. High performance computers and more efficient computational techniques have changed statistical computations and analyses for ever.

Starting from developing curricula and course materials to conducting assessments and finalisation of grades for the students computers are used everywhere. This is true for almost all subjects and discipline, and all level of education in the developed world. But it is more so to the teaching and learning of statistics, because teaching and learning of statistics needs

computations. Moreover, exploration of many core concepts in statistics requires illustration and demonstration which are much easier to handle using computer. Teaching courses on statistical computing, data analysis, research methodology, and statistical consultancy are impossible without computers and statistical packages or programming.

Figure 4.1 summarises various interactions and path-ways between the lecturer/instructor and students, and among the students themselves for teaching and learning via internet. Such interactive teaching include activities and resources such as (1) discussion groups (2) emails (3) lecture/tutorial notes (4) assignments and quizzes with feedback (5) CMA's with feedback (6) previous or example exams with solutions (7) video snippets of concepts and instructions (8) SMS PALS (9) review problems with solutions and (10) study book.

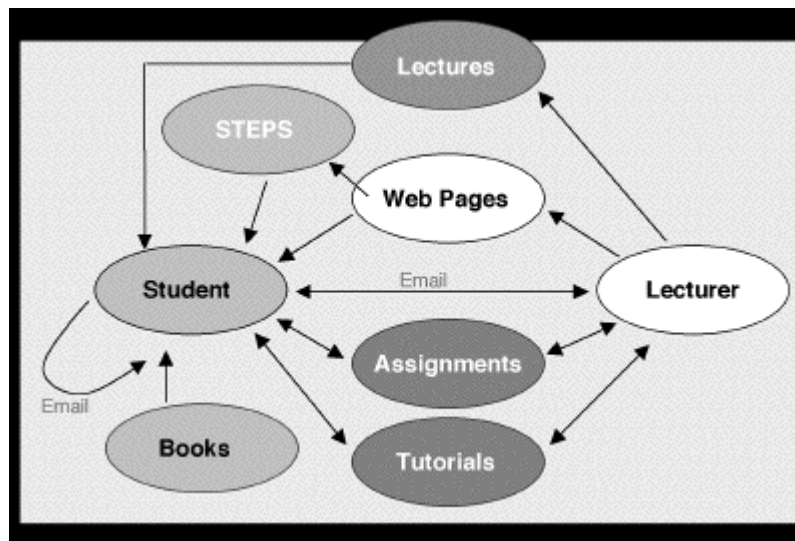


Figure 4.1 Diverse use of the internet in the teaching and learning of Statistics

4.1 Teaching technologies and softwares

Preparation and presentation of good quality course materials is always a big challenge. This becomes more challenging when teaching statistics to external students spread all over the world. Multimedia and various software have made it lot easier to prepare electronic materials with various charts and pictures without compromising quality and colour. Virtual pictures and preset templates as well as softwares to present complicated mathematical formulas and equations with great layout have made life easier for both learners and teachers. Often these teaching aids are available for free and many of them are open source to make them easily available and allow further improvements by the users and experts. Development of course technology is a growing business as internet based teaching and learning are becoming more and more popular.

PowerPoint presentation is popular both in academia and business. It is handy to put in all the presentation material in a file and present to the audience in a very systematic, organised and professional manner. Prior preparation and careful editing not only minimises the chances of omission of intended materials but also help present them in an orderly fashion that makes it more appealing to the audience. Users of non-Windows operating system have developed other

types of softwares for comparable presentations. As an example, the beamer package (document class) in LaTeX is an alternative to PowerPoint product of Microsoft.

Pre-recorded video snippets are a great way of communicating with students, both within the face-to-face class and outside the traditional classroom. Interestingly any such video or audio records are no more than computer files, and hence can be stored, shared and managed just like any other computer files. Voice over internet protocol (VOIP) technology, Access Grid Room (AGR), and satellite sessions or video conferences are also in use for teaching external students. Internet chat and group PALS (peer assisted learning strategy) are also attractive to external learners.

Electronic platforms are very successful in presenting course materials as well as managing assessments electronically. EdAlive, WebCT, Blackboard, Moodle, Wimba etc are used by many institutions of higher learning for electronic teaching, interaction, communication, and assessments. Apart from making the formal lectures and tutorials available to the students from all over the world via internet in a secured site, these platforms are able to provide facilities for discussion forums and exchange of emails among students, distribute and evaluate assessment items, monitor the progress of students, provide feedback and make announcements to the whole class on topics of common interest and events. For details on various resources on teaching Statistics refer to <http://www.ats.ucla.edu/STAT/seminars/statteach/sites.htm> and Teaching Resources, a portal for statistical science, at <http://www.statsci.org/teaching.html>

Use of course homepage or study desk on the internet for making teaching materials available to the students in their own time and from their place of residence is also popular and becoming an alternative to conventional distance teaching by correspondence. Properly maintained and timely updated course homepage is very useful to the students, if they have access to broadband internet. Otherwise, use of such electronic materials on the Web may be frustrating, if not restrictive.

4.1.1 Online assessments

Assessment plays a central role in student learning regardless of the mode of teaching or delivery. Online learning can challenge students to learn new skills and ways of studying and learning. Online assessment is one of many modes that may be used to indicate to students which aspects of their learning are valued and will be rewarded. The use of on-line tools to assess learner progress toward subject objectives can take many forms including:

- Electronic submission of written assignments
- Electronic marking of assignments
- Parallel print and on-line assessment options where students are given the choice of whether and how they use online tools in assessment tasks
- Publication of documents on the web
- Labelling and manipulation of online graphs
- Completion of online quizzes
- Completion of short-answer and multiple choice questions
- Online exams with monitored and controlled start and stop times
- Any formative or summative task carried out in a web-based environment.

Of course recording and calculation of marks and finalisation of grades of the students are much easier using computer software than otherwise. Similarly, record keeping of academic history or transcript is also conveniently done via computers. See James, R., McInnis, C. and Devlin, M. (2002), and Australian Universities Teaching Committee Report for further details.

4.2 Research collaboration, publication, training and tools

Statistical methods and techniques are developed by Statisticians, but they are used in many disciplines for decision making. Often, statistical investigations involve team work to pull together experts from more than one disciplines to solve problems and reveal new knowledge. Due to the extensive and increasing use of statistics in scientific research often statistical research is collaborative in nature. In many studies, several scientists and researchers work together as members of team to conduct collaborative research. Computer and internet have made all these joint work convenient and less time consuming. Common suppositories, epints, sharepoints, blogs etc are handy tools for flexible access to the data and material under development for successful collaboration.

Research training and supervision of research students require materials on latest contributions in the field of interest. Literature search often is the first step for the research student to decide on the research topic. Journal articles and research books and monographs are the primary sources of initial investigations. Many journals are published electronically and many more are accessible via internet. Old issues of leading journals are also available electronically and could be located and downloaded via internet. Many useful articles could be searched and printed from the home and office computer. Subject search using any search engine makes it convenient to gather initial list of publications in any area of interest. Dependence on the hardcopy of published articles is diminishing quickly as electronic copy of the same are available almost instantly. No wonder the universities and research institutions are increasingly subscribing electronic journals.

Every statistical package provides support services to its customers, clients and users. User groups or members on the mailing list of many statistical packages interact frequently to enhance research and ongoing improvement of statistical packages to address the needs of the users and researchers. Such interactions are particularly useful to young researchers who may need help when faced with new problems. They also act as forum to share expertise and latest developments in the field.

The introduction of internet has made it much easier to supervise research students externally. It is no more essential to leave your country of residence to acquire a research degree if you have access to internet. Supervisor could guide the research studies from anywhere in the world via internet. Many internet platforms (eg Skype) provide free discussions over the VOIP, and it can be used for teaching and learning as well as supervision of higher degrees students. The role of internet in the statistical research in medical studies is covered by Eysenbach and Wyatt (2002).

Submissions and review process of research papers in many professional journals are electronic, and managed by computer programs. All these are done within a secured electronic communication system. It has made the editorial job much easier and reviewers could also submit review reports electronically. Publishers prefer manuscript prepared in specific type-setting software to meet their specific format and standard. Proofreading and delegation of

copyright authority are also done via internet. All these computer and internet processing of publication have contributed to more accurate and timely publication of research results and outputs for the benefit of the authors, researchers and the end users. The libraries and other collectors of books and journals are also moving for electronic subscriptions for financial and easiness of access reasons.

Appendix – A and Appendix – B include a wide range of information and references to the various uses of computer and internet for teaching and learning Statistics.

5 Concluding remarks

The use of computer and internet is no more a choice for the learned community. It is now the rule, rather than the exception. We are living in an age where electronic signature is as good as traditional signature or old fashion finger print. Buying and selling of goods and services are being done over the internet. In fact, many items are cheaper to buy directly over the internet than from the shops. Many Government offices are providing their services on-line. Clients and users find it more convenient to communicate via internet. Businesses are using internet to promote their products and services. Young people are glued to the ICT and love to use it for almost everything they could think, and there is no questions about its growing role and need for the future generation. The mobile technology (eg ipod, ipad) has made the use of ICT more flexible and user friendly as well as popular.

Computer and internet are more used in the education industry for teaching and learning than anywhere else. They are essential for statistical activities, including teaching statistical concepts, methods, analyses and software packages. Statistical research, research training and publication of research outputs are impossible without computers. The technology is growing fast, and attracting more and more user everyday. So, it is for the benefit of the subject of Statistics, and Statisticians in general, to take advantages of available technology to enhance and promote statistical activities as well as train future generation of Statisticians.

Unfortunately for the vast majority of the people in the developing countries computer is simply unaffordable, and internet is totally inaccessible. Obviously, the benefit of the use of the ICT is very limited for them. This is equally true for the teachers and learners from these countries. While efforts to make the ICT affordable to these people should be a priority, the rest of the world would move forward regardless. This digital divide (see Shiraz et al. 2010) is an issue that deserves attention from everyone in the decision making at the local, regional and international level. The development of the poor nations would largely depend on the improvement of the education, and in the modern age computer and internet are essential parts of any effective education curriculum.

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11. Statistical Economic and Social Research and Training Centre for Islamic Countries (SESRTCIC), (accessed on 09/06/2008), http://www.sesrtcic.org/stat_database.php
12. Teaching Resources, A portal for statistical science, the discipline of statistics, (accessed on 09/06/2008), <http://www.statsci.org/teaching.html>

Appendix – A: Teaching Resources

<http://www.statsci.org/teaching.html>

Australian Resources

- [What is Statistics?](#). Lively case studies from science, finance and sport introducing visitors to statistical thinking. University of Melbourne.
- [Chance and Data in the News](#). Articles illustrating statistical principles from the Tasmanian metropolitan daily newspaper, The Mercury, with discussions by Jane Watson of the University of Tasmania. A joint project of The Mercury, the University of Tasmania, and the Australian Association of Mathematics Teachers.
- [Project Manual for Engineering Statistics](#). A guide for students doing their own data collection and analysis. Includes and glossary of statistical terms and brief recipes for using basic statistical techniques. Catriona Hayes and Helen MacGillivray, Queensland University of Technology.
- [Surfstat Australia](#). An online text in introductory statistics. Keith Dear, Australian National University.

Directories of Resources

- [Math Forum - Probability and Statistics](#). Links to teaching resources for K-12 and college level courses. Swarthmore College.
- [Statistics Education Links](#). A substantial list of links related to statistics education. Jura Puranen, University of Helsinki.
- [Teaching Bookmark Database](#). Follow the link for "Teaching" on the left-hand panel. Jan de Leeuw, University of California, Los Angeles.
- [Web Pages that Perform Statistical Calculations](#). Links to over 300 statistical sites using CGI, Java or JavaScript. John Pezzulo, Georgetown University.

Online Tutorials or Textbooks

- [Basic Principles of Statistical Analysis](#). A mini-textbook. The chapter headings are Introduction, Basics concepts of statistical models, Mixed model, Choosing between fixed and random effects, Estimating variances and covariances, Estimating fixed effects, Predicting random effects, Inference space, Conclusions and Some references. Bob Baker, University of Saskatchewan, Saskatoon.
- [CAST](#). Computer-assisted statistics teaching. A comprehensive textbook on a computer. Douglas Stirling, Massey University.
- [Defense Acquisition University Stat Refresher](#). An interactive tutorial covering basic probability, random variables, moments, distributions, data analysis including regression, moving averages, exponential smoothing, and clustering. Designed for the Defense Acquisition University by the Center for the New Engineer, George Mason University.
- [Electronic Statistics Textbook](#). An online textbook, with brief comments on a wide range of topics from basic to advanced, including variance components, neural networks, multidimensional scaling and so on. The emphasis is on techniques rather than concepts or mathematics. StatSoft Inc.

- [HipEstat](#). An online textbook in Spanish. Juan Martínez de Lejarza and Ignacio Martínez de Lejarza, Universidad de Valencia.
- [HyperStat Online](#). A substantial introductory-level statistics book including power, factorial ANOVA, between and within-subjects ANOVA, chi-square and distribution-free tests. David Lane, Rice University.
- [Online Statistics Textbook](#) by Jan de Leeuw, University of California, Los Angeles.
- [Psychological Statistics at SMSU](#). Online textbooks and extensive course materials. David Stockburger, Southwest Missouri State University.
- [Statistics Every Writer Should Know](#). A series of very user friendly beginning tutorials on statistics, suitable for school students as well as non-mathematics undergraduates. Robert Niles.
- [Stat Trek](#). An online tutorial on probability, hypothesis testing and survey sampling, as well as some online probability calculators.

Interactive Demonstrations

- [Elementary Statistics Applets](#). Interactive java applets for Student's t-Test, ANOVA, Simple Least Squares and Spearman's Rank Correlation. Bryan Lewis, Kent State University.
- [Java Applets](#). Links to various Java applications for teaching statistics. Duke University.
- [Probability by Surprise](#). Teaching by paradox. Graphics and animations for developed for teaching introductory probability. Susan Holmes, Stanford University.
- [StatiBot](#). An interactive www-based expert system for basic statistical analysis. Has a nice interface. Dominik Heeb, Switzerland.
- [Virtual Laboratories in Statistics](#). A National Science Foundation funded project to develop interactive modules for introductory statistics. Kyle Siegrist, University of Alabama, Huntsville.

Video Series/CDs

- [Against All Odds: Inside Statistics](#). Information about the video telecourse series. The Annenberg/CPB Project.
- [Against All Odds: Detailed Timings](#). Timings of the vignettes in each video of the Against All Odds series. Essential for integrating the videos into a lecture series. Gordon Smyth, Walter and Eliza Hall Institute of Medical Research.
- [Art of the Experiment](#). Information about the educational CD for sale through Amazon. Symynet.

General Resources

- [Academic Assistance Access](#). Provides free tutorial assistance to students in a number of high school and college students using a mailing list format. There is a dedicated mailing list for statistics.
- [Annenberg/CPB Projects Learner Online](#). Using telecommunications to improve learning. Corporation for Public Broadcasting with funding from the Annenberg School of Communications.
 - [Statistics Exhibit: Polls: What do the numbers tell us](#). An online program about polling and surveys in the style of the Against All Odds video series.

- [ASA Section on Statistical Education](#). Includes the newsletter of the section online. Department of Statistics, North Carolina State University.
- [Berrie's Statistics Page](#). Illustrates some probability and statistics concepts, such as the Poisson distribution and the Central Limit Theorem, using short videos. Netherlands.
- [Chance Database](#). This data base contains materials designed help teach a Chance course or a more standard introductory probability or statistics course. The aim of a Chance course is make students more informed and critical readers of current news involving statistical issues as it appears in newspapers, journals and magazines. Laurie Snell, Dartmouth College.
- [Case Studies in Statistics](#). Jan de Leeuw, University of California, Los Angeles.
- [Learning and Teaching Support Network: Maths, Stats and OR](#). Includes the Allstat mailing list. Based at the University of Glasgow.
- [EdStat News Archive](#). Department of Statistics, North Carolina State University.
- [Electronic Encyclopedia of Statistical Examples and Exercises](#). Will contain real world examples of the abuses and uses of statistics. The current web site is a preview. Ohio State University.
- [Gary C Ramseyer's First Internet Gallery of Statistics Jokes](#). Gary Ramseyer, Illinois State University.
- [Glossary of Statistical Terms](#). Howard Hoffman, Bryn Mawr College.
- [International Association of Statistical Education](#). A section of the ISI.
- [Simpson Paradox](#). A light-hearted essay. Alan Crowe.
- [SMART: Statistics and Mathematics as Advanced Research Tools](#). A series of integrated modules (an `explorapedia') for training scientists and research students in the biosciences in statistical techniques. A collaborative project coordinated by Mike Talbot, University of Edinburgh. Includes an extensive directory of other statistics education projects on the Web.
- [Statistical Instruction Internet Palette](#). A palette of resources for statistics students and instructors, including a data gallery, a data web, computing and graphing studios and an annotated formula gallery. John Behrens, Arizona State University.
 - [Web Data](#), [Data Gallery](#) [Equation Gallery](#)
- [Statistically Speaking: a Dictionary of Quotations](#). Information about the book, with several example quotations. Carl Gaither and Alma Cavazos-Gaither.
- [Statistics Education Bibliography](#). A large, partially annotated, list of references on teaching statistics compiled by Sashi Sharma and Andy Begg, University of Waikato, New Zealand. Online at the University of Perugia.
- [Stats Notes: Learning Materials and Quizzes](#). Russel John, Mathematics and Statistics, Murdoch University, Australia.

Historical

- [Earliest Uses of Symbols of Statistics](#). Why do we use rho for correlation, F for the F-ratio and t for Student's t etc? Jeff Miller, Gulf High School, Florida.
- [Famous Statisticians](#). Pictures and short biographies. Jan De Leeuw, UC Los Angeles.

Appendix – B: Resources for Teaching Statistics

<http://www.ats.ucla.edu/STAT/seminars/statteach/sites.htm>

Resources for Teaching Statistical Packages

- [SAS Starter Kit](#)
- [Stata Starter Kit](#)
- [SPSS Starter Kit](#)
- The [Statistics Books for Loan](#) page links to web resources associated with many Statistics books, including online data, errata, and sample programs. These books are available for loan to you as teachers (not for your students).
- [SAS Academic Training Kits](#) provides university instructors with course notes, slides and data sets to any of SAS Education's more than 50 courses.

Resources for Developing Content for the Web

- The [sas2htm](#) and [stata2htm](#) tools can help you convert sample SAS programs and sample Stata programs into web pages.
- The [Making Instructional Movies for Downloading Over the Web](#) page illustrates how you can capture images from your computer screen and make movies that can be delivered over the web.

Resources for Teaching Statistical Concepts

- **Sites with numerous demonstrations/simulations**
 - [Rice Virtual Lab in Statistics](#) <http://onlinestatbook.com/rvls.html>
 - [Virtual Laboratory in Probability and Statistics](#)
 - [Java Demos for Probability and Statistics](#) (some with Java source code)
 - [Applets for the Cybergnostics project](#)
 - [The Education Section of the American Statistical Association](#)
- **Individual demonstrations/simulations**
 - [A Histogram Applet](#)
 - [A Confidence Interval Applet](#)
 - [A Central Limit Theorem Applet](#)
 - [A Regression Applet](#)
 - [Hypothesis Testing Power Applet](#)
 - [Analysis of Variance Applet](#)
 - [Understanding ANOVA visually](#)

Data for Teaching Statistics

- [Case Studies \(from the UCLA Department of Statistics\)](#)
- [Statistics Course Lab Datasets \(from the UCLA Department of Statistics\)](#)
- [Statistics Labs \(from the UCLA Department of Statistics\)](#)
- [Electronic Dataset Service](#)
- [The Data and Story Library \(DASL\)](#)
- [StatLib Dataset Archive \(from the CMU Department of Statistics\)](#)

Web Based Textbooks

- [Seeing Statistics](#)
- [Concepts and Applications of Inferential Statistics](#)
- [HyperStat Statistics Textbook](#)
- [SticiGui Text](#)
- [Statistics at Square One](#)
- [PA 765 Statnotes: An Online Textbook](#)
- [Engineering Statistics Handbook](#)
- [The Little Handbook of Statistical Practice](#) by Gerard E. Dallal at Tufts University